NORTH AMERICAN SPECIES OF PUCCINIA ON CAREX[1]

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In spite of an accumulation of considerable information concerning the North American sedge rusts most mycologists have regarded this group as especially difficult. This is perhaps due to the fact that the telia and teliospores do not usually present diagnostic characters. In the characterization of these species it has been necessary to look for other features, and as has been the case in several other groups of the rusts, it has been found that the urediniospores have furnished reliable characters in many instances. The aecial connections as brought to light by cultures are also important. The presence of amphispores in some of these species, the correlation of some species with forms usually regarded as belonging to another genus, and the splitting of other species into races lend general biological interest to these studies.

In order that the results may be made as available as possible to those wishing to collect, or determine specimens of the group, considerable attention has been given to the preparation of keys and indices. The key relating to the aecial forms is somewhat unique and yet it is believed that even a cursory glance will reveal the way in which it may be useful. It is the idea that anyone having an aecial stage on a known genus of host should be able to make out whether or not it belongs to a Carex rust, and if so, to locate the species without difficulty. No host bears the aecia of more than one species. Altogether thirty genera serve as aecial hosts distributed among ten families, only one of which is monocotyledonous. Eight orders are represented. The following table shows the distribution of the aecial hosts.

[1] Read before the Botanical Society of America at the New York meeting, December 30, 1916. Contribution from the Department of Botany, The Pennsylvania State College, No. 10.

TABULAR VIEW OF THE AECIAL HOST FAMILIES

Class	Order	Family	Fam. No.*	Genera†
Monocotyledoneae	Liliales	Smilaceae	25	1
Dicotyledoneae	Urticales	Urticaceae	43	2
	Rosales	Grossulariaceae	84	1
	Myrtales	Lythraceae	128	1
		Onagraceae	130	4
	Primulales	Primulaceae	142	2
	Polemoniales	Phrymaceae	169	1
	Rubiales	Caprifoliaceae	172	1
	Campanulales	Cichoriaceae	179	7
		Carduaceae	181	10

* The number given here is the serial number of the families of the angiosperms according to Britton & Brown, Illustrated Flora, 2d edition.

† The numbers in this column indicate the number of genera in a family known to bear aecia.

Under the accounts of the species it has been the aim to include various notes which might not find a place in a purely systematic presentation. No attempt has been made to describe the aecial stages and for the sake of brevity the descriptions of the uredinial and telial stages have been confined chiefly to the spores, the sori being mentioned in only a few instances because they do not furnish diagnostic characters as a rule. Nineteen species are now recognized, of which twelve have their life-histories worked out, three possess amphispores, and three are described as new. Six of the species are common to Europe and North America, one to Asia and North America, and one is known to occur also in South America. A total of 139 species of *Carex* are listed in this paper as hosts for the species of *Puccinia*. In 1913, 106 *Carex* species were known to serve as hosts which were then represented by 1200 North American collections in the Arthur Herbarium.[2] It is not known how many collections have been added during the last three years but the herbarium has been increasing rapidly.

No effort has been spared to make the host determinations as authentic as possible and in this connection thanks are due to Dr. Theo. Holm, of Washington, D. C., and to Mr. K. K. Mackenzie, of New York, for their painstaking examination of specimens

[2] Other interesting statistics regarding the North American Carex rusts are given by Professor Arthur in Mycologia 5: 240–244 (1913).

submitted to them. This work of host determination has been tedious; the opening of the mycological packets and the fragmentary condition of many of the specimens must frequently have been irksone to phanerogamic botanists but these gentlemen have most cheerfully responded to numerous requests for identification.[3]

In making up the lists of hosts under the different species only the names considered to be most acceptable are included, omitting all which are regarded as synonyms. In order to make these synonyms, some of which may be commonly known, also available they are included in the Index to Rusts Occurring on Various Species of Carex at the end of this paper, with proper cross references.

The studies have been carried on over a considerable interval, ten years or more, during which time the routine duties of teaching and experiment station work have claimed the larger share of effort, and yet there has been a continuous interest and numerous periods of varied extent have been devoted wholly to this group. The work which has been done directly with the idea of preparing a monographic account has been made possible only by the initial and continued support of Professor J. C. Arthur and his staff of botanical assistants, among whom Miss Mary A. Fitch deserves especial mention. The painstaking observations and careful records made by Miss Fitch at a time when the whole matter was in a very chaotic condition assisted very materially in establishing a working basis. Five years ago a paper entitled A Revision of the North American species of Puccinia on Carex was presented in brief form by the writer before the Botanical Society of America.[4] Miss Fitch was included as a joint author but the paper was published only in abstract form.[5] Since that presentation the studies have been continued, but without the aid of Miss Fitch, and the results of the more recent work are incorporated in this paper. The value of the foundational work of Professor Arthur and of his continued assistance cannot be overestimated.

[3] For notes concerning the activities of Dr. Holm see Torreya **13**: 72 (1913) and Mycologia **5**: 240–244 (1913).

[4] Washington meeting, December 27, 1911.

[5] Science, N. S. **35**: 150. 1912.

For collections of specimens and suggestions as to relationships thanks are due to generous friends in various parts of the country and are hereby most heartily accorded.

A. Uredinia and telia exclusively considered

Host belonging to genus *Carex* (family Cyperaceae).
- Urediniospores with pores in an equatorial zone.
  - Pores 2 (in occasional spores 3).
    - Urediniospores medium-sized (16–21 × 20–26 μ), wall 1–2 μ thick.
      - Urediniospores of the modified sort (amphispores) unknown ..... 1. *P. Kellermanii.*
      - Urediniospores of the modified sort (amphispores) with chestnut-brown wall, thicker above ..... 2. *P. atro-fusca.*
    - Urediniospores very large (26–37 × 35–61 μ), wall 2.5–3.5 μ thick ..... 3. *P. macrospora.*
  - Pores 3 (in occasional spores 4).
    - Urediniospore-wall moderately thick (2 μ and more) ..... 4. *P. spatiosa.*
    - Urediniospore-wall moderately thin (2 μ and less).
      - Urediniospores rather large (18–26 × 24–39 μ).
        - Teliospores small (26–42 μ long). 5. *P. minuta.*
        - Teliospores large (39–71 μ)..... 6. *P. urticata.*
      - Urediniospores medium-sized (15–21 × 19–32 μ).
        - Teliospores moderately small (32–45 μ long); urediniospore-wall cinnamon-brown ..... 7. *P. Lysimachiae.*
        - Teliospores medium-sized (32–58 μ long), urediniospore-wall golden-brown ..... 8. *P. Grossulariae.*
        - Teliospores large (45–67 μ long), urediniospore-wall cinnamon-brown ..... 9. *P. eminens.*
  - Pores 4, urediniospores pale yellow; urediniospores of the modified sort (amphispores), chestnut-brown with 2 equatorial pores.....10. *P. microsora.*
- Urediniospores with pores in an extra-equatorial zone.
  - Pores 2, above the equator.
    - Pores slightly above the equator, i. e., superequatorial.
      - Urediniospores small (12–18 × 16–21 μ) wall golden-brown. .....11. *P. minutissima.*
      - Urediniospores medium-sized (15–

20 × 20–26 μ) wall cinnamon-brown ..... 12. *P. universalis.*
Pores considerably above the equator, i. e., in the upper part of spore.
Urediniospores small (12–19 × 16–23 μ).
Teliospores small (29–45 μ long).. 13. *P. Phrymae.*
Teliospores medium-sized (25–50 μ or more, long)..... 14. *P. asterum.*
Urediniospores medium-sized (15–20 × 19–26 μ).
Telia roundish or oval, comparatively broad ..... 15. *P. Peckii.*
Telia mostly oblong or linear, comparatively narrow ..... 16. *P. patruelis.*
Urediniospores rather large (17–23 × 24–32 μ), chiefly lenticular ..... 17. *P. Sambuci.*
Pores 1 or 2, below the equator.
Pores 2, slightly below the equator, i. e., subequatorial ..... 18. *P. Caricis-strictae.*
Pore 1, considerably below the equator, near the hilum ..... 8. *P. Grossulariae.*
Urediniospores with scattered pores ..... 19. *P. karelica.*

B. **Aecia exclusively considered**

Aecia scattered, from diffused mycelium ..... Excluded.
Aecia grouped, from limited mycelium.
Aecia rupturing by an ostiolar pore ..... Excluded.
Aecia cupulate.
Host belonging to family Smilaceae (genus *Smilax*).
Aeciospores medium-sized (15–26 μ), the wall uniform ..... Excluded.
Aeciospores very large (32–51 μ), the wall much thicker above ..... 3. *P. macrospora.*
Host belonging to family Urticaceae.
Host belonging to genus *Boehmeria,* aeciospores very small (10–13 μ) ..... Excluded.
Host belonging to genus *Urtica,* aeciospores medium-sized (15–23 μ) ..... 6. *P. urticata.*
Host belonging to family Grossulariae (genus *Ribes*) ..... 8. *P. Grossulariae.*
Host belonging to family Lythraceae (genus *Decodon*) ..... 11. *P. minutissima.*
Host belonging to family Onagraceae.
Host belonging to genus *Ludwigia* or *Anogra* ..... Excluded.
Host belonging to genus *Gaura, Onagra, Meriolix,* or *Pachylophus* ..... 15. *P. Peckii.*

Host belonging to family Primulaceae.
  Host belonging to genus *Glaux* or *Steironema* ..... Excluded.
  Host belonging to genus *Lysimachia* ..... 7. *P. Lysimachiae.*
  Host belonging to genus *Trientalis* ..... 19. *P. karelica.*
Host belonging to family Phrymaceae (genus *Phryma*) ..... 13. *P. Phrymae.*
Host belonging to family Caprifoliaceae (genus *Sambucus*) ..... 17. *P. Sambuci.*
Host belonging to family Cichoriaceae.
  Host belonging to genus *Lampsana* ..... Excluded.
  Host belonging to genus *Adopogon, Agoseris, Crepis, Lactuca, Nothocalais, Hieracium* or *Prenanthes* ..... 16. *P. patruelis.*
Host belonging to family Carduaceae.
  Host belonging to genus *Ageratum, Arnica, Bahia, Bigelovia, Boltonia* (uncertain), *Borrichia, Carduus, Chrysogonum, Chrysopsis, Chrysothamnus, Cirsium, Clibadium, Coleosanthus, Conoclinium, Desmanthodium, Dugaldia, Eriophyllum, Eupatorium, Gnaphalium, Gutierrezia, Gymnolomia, Helenium, Helianthus, Helianthella, Heliopsis, Laciniaria, Montanoa, Polymnia, Rudbeckia, Senecio, Silphium, Verbesina, Ximenesia,* or *Zexmenia* ..... Excluded.
  Host belonging to genus *Aster, Doellingeria, Eucephalus, Euthamia, Erigeron, Grindelia, Leptilon, Oreochrysum* or *Solidago* ..... 14. *P. asterum.*
  Host belonging to genus *Artemisia* ..... 12. *P. universalis.*

1. **Puccinia Kellermanii** sp. nov.

O & I. Pycnia and aecia unknown.

II. Urediniospores ellipsoid, 18–21 × 25–28 μ; wall light golden-brown about 1.5 μ thick, moderately and distinctly echinulate, the pores 2, or sometimes 3, equatorial.

III. Telia scattered, chiefly on the upper part of the culm or on the rachis, oval or oblong, 0.4–0.8 mm. long, early naked, chocolate-brown; teliospores clavate-oblong, 16–21 × 39–45 μ, rounded or sometimes narrowed above, usually narrowed below, slightly constricted at the septum; wall varying from golden- to chestnut-brown, 1–1.5 μ thick, much thicker above, 9–10 μ; pedicel tinted next to the spore, once to once and a half length of spore.

On *Carex polystachya.*

Type collected near Antigua, Depart. Sacatepéquez, Guatemala, Feb. 3, 1908, *W. A. Kellerman, 7197;* other collections San Rafael, Jan. 10, 1915, *55*, and Solola, Jan. *27*, 1915, *124*, both by *E. W. D. Holway.*

The Guatemalan collections here listed are used as the foundation of a new species. The pore arrangement throws this species in a group with *P. atro-fusca* and *P. macrospora* from which it differs markedly in other spore characters. There is a general resemblance to *P. urticata* but the pores in the Guatemalan specimens are usually *2*, sometimes 3, whereas they are usually 3, rarely 4, in *P. urticata;* there are also differences in teliospores. The variations in spore characters plus the geographic interval between these specimens and any of the other species makes it seem wise to characterize a new species.

2. PUCCINIA ATRO-FUSCA (Dudley & Thomp.) Holway, Jour. Myc. **10**: 228. 1904

Uromyces atro-fuscus Dudley & Thomp. Jour. Myc. **10**: 55. 1904.

O & I. Pycnia and aecia unknown.

II. Urediniospores of the typical sort broadly ellipsoid, 16–21 × 21–26 μ; wall cinnamon-brown, 1.5–2 μ thick, rather closely echinulate, the pores 2, equatorial; urediniospores of the modified sort (amphispores) broadly ellipsoid or obovoid, 17–24 × 23–32 μ; wall chestnut-brown, 2.5–3.5 μ thick, somewhat thicker above, 4–7 μ, rather sparsely but prominently verrucose-echinulate especially above, the pores 2, approximately equatorial.

III. Teliospores narrowly obovate-ellipsoid or clavate-oblong, 16–22 × 30–43 μ, rounded or obtuse at each end, slightly constricted at the septum; wall chestnut-brown, 1.5–2 μ, much thicker above, 5–7 μ; pedicel slightly tinted, about length of spore.

On *Carex Douglasii, nigricans, praegracilis, siccata.*

DISTRIBUTION: Southern Alberta, Montana, and New Mexico west to the Pacific Coast.

EXSICCATI[6]: Barth. N. Am. Ured. *820, 1027;* Clements, Crypt. Colorad. Form. *547*; Barth. Fungi Columb. *2676, 3742.*

[6] In listing the Exsiccati those on the *Carex* host are given first and italicized; those on the aecial host are set apart by a dash and are not italicized.

The chief point of interest in connection with this species is the presence of two sorts of urediniospores. The urediniospores of the modified sort have been called amphispores. The chief modification is a greater thickness of wall presumably fitting them for living over winter. In some species amphispores are modified as to markings and pore arrangement. In this species the markings are more verrucose in their nature and more prominent but the pore arrangement is the same. The characters of the sori differ also, the amphisori being twice as large, more pulvinate and dark-chocolate-brown as compared with the cinnamon-brown uredinia. These amphispores have never been germinated but in other cases amphispores have been demonstrated to germinate and produce infection in the same manner as urediniospores.

3. PUCCINIA MACROSPORA (Peck) Arth. Mycologia **1**: 244. 1909
Aecidium macrosporum Peck, Ann. Rep. N. Y. State Mus. **23**: 61, 1873. Not *A. macrosporum* Diet. & Neg. 1896.

O & I. Pycnia and aecia on *Smilax* spp. (For cultures see Mycologia **1**: 243, 1909.)

II. Urediniospores obovate or narrowly ellipsoid, rather irregular, very large, 26–27 × 35–61 μ, often narrowed below to a thickened hilum; wall golden yellow, 2.5–3.5 μ thick, echinulate with prominent points 3–4 μ apart, the pores obscure, 2, or sometimes 3, equatorial.

III. Teliospores clavate, 16–23 × 61–67 μ, usually rounded or obtuse above, narrowed below, often slightly constricted at the septum; wall pale-cinnamon-brown, paler below, 1.5–2.5 μ, much thicker above, 9–16 μ; pedicel colorless, one half to once length of spore.

On *Carex comosa.*

DISTRIBUTION: Limited area near the coast from Long Island to Delaware, with a single collection of aecia from Kansas.

This is a remarkable but little known species. The very large size of the urediniospores even when compared with the form belonging to *Urtica,* which has always been regarded as having large urediniospores, attracts immediate attention. The aeciospores are also exceedingly large (32–42 × 37–51 μ) and it was in fact the similarity in these spore structures which was chiefly

responsible for the original culture. There are other cases where morphological correspondence between aeciospores and urediniospores has led to successful connections (see Arthur, Bot. Gaz. **29**: 274–275, 1900). Such cases tend to indicate a possible homology between these spore forms.

4. **Puccinia spatiosa** sp. nov.

O & I. Pycnia and aecia unknown.

II. Urediniospores broadly ellipsoid, 26–29 × 30–39 μ; wall light cinnamon-brown, 2–2.5 μ thick, sparsely and conspicuously echinulate, the pores 3, or sometimes 4, approximately equatorial.

III. Telia oval oblong or linear, 0.5–1 mm. long, blackish; teliospores narrowly obovoid, 24–29 × 45–64 μ, considerably constricted at the septum, rounded above, rounded or narrowed below; wall chestnut-brown, 1.5–2 μ thick, very much thicker above, 16–23 μ; pedicel nearly colorless, once to once and a half length of spore.

On *Carex* sp.

Type collected at Brookings, S. D., March 21, 1908, *A. G. Johnson.*

So far as pore characters are concerned the form here described agrees with a group of species, of which the forms having aecia on *Urtica* and *Ribes* are prominent members, but it differs from all of these in having more robust especially broader spores, both uredinio- and teliospores. As compared with the usual oblong-clavate teliospores of the sedge rusts these are broad enough and rounded above so as to give an obovoid effect.

5. PUCCINIA MINUTA Dietel; Atkinson, Bull. Cornell Univ. **3**: 19, 1897

Puccinia riparia Holway, Jour. Myc. **10**: 163, in part. 1904.

O & I. Pycnia and aecia unknown.

II. Urediniospores broadly ellipsoid or obovoid, 19–26 × 26–39 μ; wall cinnamon-brown, about 1.5 μ thick, evenly and rather sparsely echinulate, the pores 3, approximately equatorial.

III. Teliospores clavate-oblong or cuneate, small, 13–23 × 26–42 μ, rounded or truncate above, not or only slightly constricted at the septum; wall light chestnut-brown, 1–1.5 μ thick, much thicker at apex, 5–10 μ; pedicel slightly tinted, about one-half length of spore.

On *Carex lacustris, verrucosa.*

DISTRIBUTION: Known only from separated localities, Ontario, Wisconsin, Iowa, and Alabama.

The name *minuta* was applied by Dietel to a specimen collected at Auburn, Alabama, on *C. verrucosa,* the striking characters of which are the moderately large urediniospores and the very small teliospores. *Puccinia riparia* as described by Holway possessed these same characters and his specimens agree well with Dietel's material. Mr. Holway thought that the telial form which he described was associated with an aecidium on *Ribes floridum* but repeated attempts to infect *Ribes* with these spores from *C. riparia* have failed (Bot. Gaz. **35**: 22, 1903, Jour. Myc. **14**: 14, 1908). Infection has been secured from *C. riparia* on *Urtica* but the spores are quite different from those included here. From these results it is assumed that there must have been some error about Holway's procedure. The name which he proposed evidently belongs here in part and with *Puccinia Grossulariae* in part.

6. **Puccinia urticata** (Link.) comb. nov.

Aecidium Urticae Schum. Enum. Pl. Saell. **2**: 222. 1803.
?*Uredo Caricis* Schum, Enum. Pl. Saell. **2**: 231. 1803.
Caeoma Urticae Schlecht. Fl. Berol. **2**: 112, 1824.
Caeoma urticatum Link. in Willd. Sp. Pl. **6**^{2}: 62. 1825.
Puccinia Caricis Schroet. Krypt.—Fl. Schles. **3**: 327. 1887. Not *P. Caricis* Reb. 1804.
Puccinia Urticae Lagerh. Mitt. Bad. Ver. **2**: 72. 1889. Not *P. Urticae* Barcl. 1887.
Dicaeoma Urticae Kuntze, Rev. Gen. **3**^{3}: 467. 1898.
?*Dicaeoma Caricis* Kuntze, Rev. Gen. **3**^{3}: 468. 1898.
Puccinia Garrettii Arth. Bull. Torrey Club. **32**: 41. 1905.

O & I. Pycnia and aecia on *Urtica* spp. (For cultures see Bot. Gaz. **29**: 270, 1900, **35**: 16, 1903: Jour. Myc. **12**: 15, 1906, **14**: 14, 1908, Mycologia **2**: 223, 1910, **4**: 17, 1912.)

II. Urediniospores broadly ellipsoid, rather large, 18–25 × 24–35 μ; wall golden-brown, 1.5–2μ thick, rather sparsely echinulate, the pores 3, rarely 4, equatorial.

III. Teliospores mostly clavate, 15–23 × 39–71 μ, usually rounded above, the upper cell much broader and shorter than the

lower one, narrowed below into the pedicel; wall light chestnut-brown, paler below, about 1.5μ thick, much thicker above, 7–12 μ; pedicel firm, tinted, often darker than the lower portion of the spore, one half length of the spore or less.

On *Carex acutina, amplifolia, aquatilis, atherodes, Baileyi, comosa, crinita, diandra, exilis, exsiccata, laciniata, lacustris, lanuginosa, magnifica; nebraskensis, nigricans, nudata, Pseudocyperus, retrorsa, rostrata, Sartwellii, siccata, stipata, stricta, trichocarpa, viridula.*

DISTRIBUTION: Across northern United States from Connecticut, New York and Delaware to Washington, Oregon, and Utah, and in Ontario; also in Europe, Siberia, and Japan.

EXSICCATI: Barth, Fungi Columb. *2351, 2655, 3170, 3179, 3349, 3545, 3546, 3571, 3655, 3837, 3838, 3863, 3864, 4066, 4166, 4356, 4377, 4575, 4676, 4979, 5057*—3772, 3973, 4978; Barth. N. Am. Ured. *740, 770, 940, 1081, 1082, 1242*—972; Brenckle, Fungi Dakot. *12, 294*—118; Clements, Crypt. Form. Colorad. *550, 551*—601; Ellis & Ev. Fungi Columb. *1468, 1759*; Garrett, Fungi Utah, *44, 45, 129, 167, 172*; Griff, W. Am. Fungi *339*; Kellerm. Ohio Fungi, *70, 71, 192*—69; Sydow, Ured. *464, 1065, 1575*—2513.

A widely distributed and rather common *Carex* rust. The characteristic features are the moderately large urediniospores with the three, or rarely four, equatorial pores and the long clavate teliospores with the rounded upper cell which is broader and much shorter than the lower cell. On the most of the hosts listed the spores are characteristic and placed here with considerable confidence. The form of *C. nebraskensis,* formerly determined as *C. Hoodii,* was at one time named *Puccinia Garrettii* and described as having amphispores. The tendency of these spores toward thicker walls and retention of pedicels is perhaps better interpreted as a condition of slight immaturity than as a modification toward a resting condition, which we now believe to go with genuine amphispores. Both culture evidence and field observations favor the present disposition.

7. **Puccinia lysimachiata** (Link) comb. nov.

Aecidium Lysimachiae Schw. Schrift. Nat. Ges. Leipzig 1: 67. 1822. Not *P. Lyssimachiae* Karst. 1879.

Caeoma Lysimachiae Schlecht. Fl. Berol. **2**: 113. 1824.
Caeoma lysimachiatum Link, in Willd. Sp. Pl. **6**[2]: 45. 1825.
Aecidium Lysimachiae Schlecht.; Wallr. Fl. Crypt. Germ. **2**: 252. 1833.
Puccinia Limosae Magn. Amtl. Ber. Vers. Deutsch. Naturf. u. Aerzte **1877**: 200. 1877.
Dicaeoma Lysimachiae Kuntze, Rev. Gen. **3**[3]: 467. 1898.

O & I. Pycnia and aecia on *Lysimachia* spp. (Cultures in Europe but not yet made with North American material.)

II. Urediniospores broadly ellipsoid or obovoid, 17–19 × 20–25 μ; wall cinnamon-brown, 1.5–2 μ thick, evenly and rather sparsely echinulate, the pores 3 or 4, equatorial.

III. Teliospores oblong or oblong-clavate, 15–19 × 32–45 μ, rounded or truncate at the apex, usually narrowed below, slightly constricted at the septum; wall dark chestnut-brown, somewhat paler below, 1–1.5 μ thick, much thicker above, 7–10 μ; pedicel light yellow or nearly colorless, about three-fourths length of spore.

On *Carex arcta, atratiformis brunnescens, limosa.*

DISTRIBUTION: Vermont, Connecticut, and Delaware west to Wisconsin, Nebraska, and Illinois; also in Europe.

EXSICCATI: Barth, Fungi Columb. *3848, 4153, 5064*—4152; Ellis & Ev. N. Am. Fungi, 2404.

Cultures in Europe by Magnus (1877) and by Klebahn (Jahrb. f. wissenschaft. Bot. **34**: 396, 1900) have established a connection there between a *Puccinia* on *Carex limosa* and an aecidium on *Lysimachia*. The American specimens here included agree perfectly with the European specimens and are included on the grounds of morphological similarity, even in spite of one negative attempt to make a culture from *C. limosa* on *Lysimachia*. Strong field evidence both from Dearness in Ontario and Bates in Nebraska support the connection. These aecia on *Lysimachia* are undoubtedly distinct from those on *Steironema* which are associated with telial forms on the grass *Spartina*. The aecia have been collected more frequently than the telia.

8. PUCCINIA GROSSULARIAE (Schum.) Lagerh. Ured. Herb. Fries. 60. 1895

Aecidium Rumicis β Grossulariae Pers. Synop. Fung. 207. 1801.
Aecidium Grossulariae Schum. Pl. Saell. **2**: 223. 1803.

Caeoma Grossulariatum Link, in Willd. Sp. Pl. 6^2: 59. 1825.
Puccinia Pringsheimiana Kleb. Zeits. Pflanzenkr. 4: 194. 1894.
Puccinia Magnusii Kleb. Zeits. Pflanzenkr. 5: 79. 1895.
Puccinia Ribis-nigri-acutae Kleb. Zeits. Pflanzenkr. 6: 327. 1896.
Puccinia Ribesii-Pseudocyperi Kleb. Prings. Jahrb. 34: 391. 1899.
Puccinia Ribis-nigri-Paniculatae Kleb. Prings. Jahrb. 34: 393. 1899.
Puccinia albiperidia Arth. Jour. Myc. 8: 53. 1902.
Aecidium albiperidium Arth. Jour. Myc. 8: 53. 1902.
Puccinia riparia Holway, Jour. Myc. 10: 163, in part. 1904.
Dicaeoma albiperidium Arth. Proc. Ind. Acad. Science 1903: 145. 1904.
Puccinia quadriporula Arth. Bull. Torrey Club 34: 586. 1907.
Puccinia Ribesii-Caricis Kleb. Zeits. Pflanzenkr. 17: 134. 1907.
Puccinia uniporula Orton, Mycologia 4: 201. 1912.

O and I. Pycnia and aecia on *Ribes* spp. (For cultures see Jour. Myc. 8: 53, 1902, 11: 58, 1905, 12: 14, 1906; Mycologia 7: 66, 1915.)

II. Urediniospores broadly ellipsoid or obovoid, 15–21 × 19–24 μ (rarely larger, up to 25 × 34 μ); wall golden-brown, 1.5–2 μ thick, finely and evenly echinulate, the pores 3, or sometimes 4, equatorial, or sometimes wholly or in part 1, close to the hilum.

III. Teliospores broadly clavate, 15–21 × 32–58 μ, rounded or truncate at the apex, narrowed below, slightly constricted; wall cinnamon-brown, 1–1.5 μ thick, thicker at apex, 4–10 μ; pedicel one-half length of spore or less.

On *Carex acutina, aquatilis, arctata, arctata* × *flexilis, brunnescens, canescens, castanea, complanata, concolor, conoidea, crinita, cryptocarpa, digitalis, disperma, eburnea, festivella* (formerly det. as *festiva*), *flava, flexuosa, Goodenowii, gracillima, gynandra, Haydeni, hirtifolia, Hitchcockiana, intumescens, Kelloggii, lanuginosa, laxiflora, macrochaeta, magnifica, maritima, Mertensii, monile, nebraskensis, obtusata, pallescens, prasina, retrorsa, scabrata, sitchensis, spectabilis, squarrosa, stipata, stricta, stygia, tetanica, trisperma, typhina, virescens.*

DISTRIBUTION: Northern United States and southern Canada from Nova Scotia and New Jersey west to northern New Mexico, Oregon, and British Columbia, and in Alaska; also in Europe.

EXSICCATI: Barth. N. Am. Ured. *447, 638, 845, 945, 1048,*

1049, 1245, 1346, 1547—222, 637, 844, 944, 1025, 1047, 1152, 1244, 1345, 1446; Barth. Fungi Columb. *2350, 2447, 2555, 2556, 3060, 3758, 4148, 4461, 4664, 4962*—3757, 3843, 3928, 3940, 4147, 4264; Brenckle, Fungi Dakot. *243, 365*—301; Clements, Crypt. Colorad. Form. 596; Ellis & Ev. Fungi Columb. 1904, 2101; Kellerm. Ohio. Fungi *149*—81, 121; Kellerm. & Sw. Kansas Fungi 27.

A *Carex* rust associated with aecia on *Ribes* is one of the most widespread species both in Europe and America. The study of these forms in America has been attended with some interesting developments. In 1901 when Arthur made the first culture in this country on *Ribes* the resulting aecia were characterized by a decidedly whitish peridium apparently quite unlike the deep orange aecia which are so abundant in North America, and the species was named *Puccinia albiperidia*. During the next few years every effort was made to determine the possible significance of the pale forms obtained by cultures. After six or seven years of culture work it was concluded that the greenhouse conditions such as shade and moist air coupled with a slower development of the fungus tended to produce the differences known to exist between the culture and field specimens. Plants infected indoors and then transferred to the garden gave practically the same appearance as natural infections. The question as to the identity between American and European material remained unsettled and the American rust was still called *Puccinia albiperidia*. In Europe several races were recognized and several names such as *Puc. Ribis-nigri-acutae* and *Puc. Ribesii-Pseudocyperi* proposed by Klebahn came into use. Just about the time that the conclusion was being reached that all *Carex* rusts both in Europe and America, having their aecial stages on *Ribes,* were races of one large species for which the name *Puc. Grossulariae* was the oldest and most appropriate name, another disturbing factor came to light.

While making a special study of the *Carex* rusts possessing 1-celled teliospores (*Uromyces* or *Nigredo*) some specimens were found having one pore, near the hilum, in the urediniospores (see Rhodora **12**: 124–127, 1910). At first this *Uromyces* was known only on *Carex tenuis* but later it was found on *C. gracillima.*

The discovery of such an unusual pore arrangement in a *Uromyces* on a sedge led to a search for urediniospores with this type of pore location in a *Puccinia*. They were found in connection with *Puccinia* forms on the two hosts mentioned and also on *C. pubescens* and *C. pallescens* all of which are hosts for the *Ribes* rust. The urediniospores which have previously been supposed to belong with the telia known to infect *Ribes* possessed three equatorial pores. The discovery of the new pore arrangement even on specimens which had been used for successful cultures suggested that two species must be intermixed. At first the tendency was toward a belief that here might exist two species both with aecia on *Ribes,* the usual one with three equatorial pores and bright colored aecia widespread in both Europe and America, and a less common but perhaps valid one with the single basal pore and pale aecia. Nothing could have been more natural than the suspicion that a structural character in the uredinial stage had now been discovered to accompany the somewhat uncertain character of the aecial stage and that *Puc. albiperidia* was entitled to specific standing. The constant presence of urediniospores with the three equatorial pores in all culture material used for successful inoculations on *Ribes* finally led to the conclusion that the telial stage of which they were a part could account for the cultures, that *Puc. albiperidia* and *Puc. Grossulariae* must after all be synonymous. This view left the form with the basal pore unnamed and unconnected. About this time C. R. Orton in making a study of correlations in the genera *Puccinia* and *Uromyces* reviewed the matter, decided the 1-pored form was a valid species correlated with *Uromyces uniporulus* and supplied the name *Puccinia uniporula* (Mycologia 4:201, 1912). Then began definite steps to learn more of its standing through cultures. It is very difficult to secure specimens in which all of the urediniospores have a single basal pore but in 1915 Arthur reports (Mycologia 8:130, 1916) that material which may be considered representatives of pure *Puc. uniporula* produced infection on *Ribes* giving aecia identical with those grown previously from material possessing three equatorial pores. There seems to be such a remarkable association of the two types of urediniospores in material capable of producing infection on *Ribes* that the pos-

sibility that we may be dealing with a species having dimorphic urediniospores is tentatively accepted. Whether this will alter the present view of the taxonomic value of pore characters or whether we are in error in uniting these two forms can be revealed only by further investigation. For further discussion of the pore problem the reader is referred to *Mycologia* 7: 28–33 (1915).

9. **Puccinia eminens** sp. nov.

O & I. Pycnia and aecia unknown.

II. Urediniospores broadly ellipsoid or obovoid, 15–21 × 23–32 μ; wall cinnamon-brown, about 1.5 μ thick, evenly and rather sparsely echinulate, the pores 3, equatorial.

III. Telia roundish or oval, 0.4–1 mm. long, early naked, chocolate-brown, teliospores broadly clavate, 13–24 × 45–67 μ; slightly constricted at the septum, rounded or more often narrowed above, narrowed below; wall chestnut-brown, 1.5–2 μ thick, much thicker above, 7–16 μ; pedicel colorless, length of spore or less.

On *Carex saximontana* Mack. (*C. durifolia subcostrata* Bates).

Type collected in Colorado, May 22, 1909. *E. Bethel;* also collected at Fort Collins, Colorado, May 24, 1896, *C. F. Baker.*

One of the most characteristic features about this species is the broad prominent telial sorus. The urediniospores agree with *Puc. urticata* in pore arrangement but differ in being smaller and darker colored. Acting upon a suggestion made by Mr. E. Bethel an attempt has been made to infect this host, *Carex saximontana,* with aecia from *Ribes longiflorum* but without success (Mycologia 8: 130, 1916). Specimens may have been distributed as on *Carex Backii* or *C. durifolia* but the Rocky Mountain plant passing under those names is *C. saximontana* Mack.

10. PUCCINIA MICROSORA Körn; Fuckel, Fungi Rhenani *2637.* 1874

Dicaeoma microsorum Kuntze, Rev. Gen. 3^3: 469. 1898.

O & I. Pycnia and aecia unknown.

II. Uredinia of the typical sort oval or oblong, 0.5–1.5 mm. long, bullate, long covered by the epidermis; urediniospores of the typical sort ellipsoid, 20–26 × 26–30 μ; wall pale yellow or nearly colorless, 1–1.5 μ thick, strongly and sharply echinulate,

the pores obscure, apparently 4, equatorial: uredinia of the modified sort (amphisori) roundish or oval, 0.3–0.6 mm. long, long covered by the epidermis; urediniospores of the modified sort (amphispores) broadly spatulate or obovoid, 20–28 × 32–48 μ; wall chestnut-brown, 2–3 μ thick, slightly thicker above 3–5 μ, sparsely and inconspicuously verrucose, the pores 2 or sometimes 3, equatorial; pedicel persistent, colorless, about length of spore.

III. Teliospores common in the amphisori, oblong or lanceolate, 13–19 × 35–50 μ, rounded or often narrowed above and below, slightly or not constricted at the septum; wall pale yellow, 1–1.5 μ thick, somewhat thicker at apex 2–4 μ; pedicel colorless; about one-third length of spore or less.

On *Carex exsiccata, Frankii, lurida, scabrata, Sprengelii, Tuckermani* (on *C. vesicaria* in Europe).

DISTRIBUTION: Known only from isolated localities in the mountains of Pennsylvania, West Virginia, Virginia, in northern Wisconsin, and on the coast of Oregon; also in Europe.

The discovery, recognition, and finding of additional specimens of this species makes an interesting story. The first specimen was sent from West Virginia by Dr. John L. Sheldon and was on *Carex Frankii.* This being a common host for *Puc. Sambuci* it was examined with the expectation of finding that species. The examination, however, showed only 1-celled, chestnut-brown spores, now known to be amphispores, but which were then taken to be teliospores of some *Uromyces.* They agreed with no known species and the specimen was laid aside as a possible new species. Several years elapsed before anything further came to light. Then Dr. J. J. Davis sent in specimens on *Carex scabrata* and *C. Tuckermani* which were at once recognized as unusual since they possessed three types of spore forms. Urediniospores of an ordinary sort and two-celled nearly colorless teliospores, indicating a *Puccinia* relationship, were present. The most numerous spores, however, were single celled, chestnut-brown, with a thickened apex. Their shape, size, and color indicated at once that they could not be considered mesospores. To be amphispores the wall should have some sort of surface marking and germ pores should be evident and further examination showed clearly that they qualified. The West Virginia specimen was then thought of and a reexamination indicated clearly that the supposed *Uromyces* telio-

spores agreed in every respect with the amphispores of the Wisconsin specimens and that the colorless *Puccinia* spores had been overlooked. The situation was still puzzling but it was evident that another sedge rust with amphispores was added to our list. To Dr. J. J. Davis is due the credit for first suggesting the possibility that his specimens might represent *Puc. microsora* Körn. A comparison of the description in Fuckel, Sym. Myc. 3:14 (1875) and a later examination of the specimen in Fungi Rhenani *2637* (1874) left no doubt as to the correctness of the suggestion. The next specimens were soon collected in central Pennsylvania and additional ones have since been sent in from Oregon and Virginia, thus showing it to be present in numerous widely separated localities.

11. PUCCINIA MINUTISSIMA Arth. Bull. Torrey Club 34:587. 1907

Aecidium Nesaeae Gerard, Bull. Torrey Club 4:47. 1873. Not *P. Nesaeae* Ellis & Ev. 1895.

O & I. Pycnia and aecia on *Decodon verticillatus*. (For cultures see Mycologia 7:245. 1915.)

II. Urediniospores globoid or broadly ellipsoid, very small, 12–18 × 16–21 μ; wall golden-brown, 1–1.5 μ, finely echinulate, the pores, 2, slightly superequatorial.

III. Teliospores oblong-clavate, 15–22 × 39–64 μ, slightly constricted at the septum, the apex rounded or obtuse, narrowed below; wall dark chestnut-brown, 1–1.5 μ thick, much thicker above, 9–13 μ; pedicel slightly tinted, about one-half length spore.

On *Carex aquatilis, lasiocarpa*.

DISTRIBUTION: In swamps or bogs of northeastern United States, from Massachusetts and Delaware west to Indiana and Wisconsin; also in Ontario.

EXSICCATI: Barth. N. Am. Ured. *801–951*—1001; Barth. Fungi Columb. 4063, 4102; Ellis & Ev. Fungi Columb. *258* (in part) *1382*; Kellerm. Ohio Fungi 91; Sydow, Ured. *2419*—2549.

This species is especially characterized by the small urediniospores in association with teliospores which are of average size. Its aecial connection also serves to set it apart from any other

species. It is evidently a bog form since both aecial and telial hosts are limited in distribution to swamps, bogs or lake margins.

12. PUCCINIA UNIVERSALIS Arth. Jour. Myc. **14**: 21, 1908

Aecidium Dracunculi Thüm. Bull. Soc. Nat. Moscow **58**: 212. 1878. Not *P. Dracunculi* Auerswald, 1850.

O & I. Pycnia and aecia on *Artemisia* spp. (For cultures see Jour. Myc. **14**: 21. 1908; Mycologia **2**: 224. 1910.)

II. Urediniospores broadly ellipsoid, 15–20 × 20–26 μ; wall cinnamon-brown, 1–1.5 μ thick, rather finely echinulate, the pores 2, equatorial or approximately equatorial.

III. Teliospores clavate-oblong, 16–26 × 35–55 μ, slightly or not constricted at the septum, rounded or obtuse above; wall dark chestnut-brown above, somewhat paler below, 1.5–2 μ thick, much thicker above 7–12 μ; pedicel tinted, one half length of spore or more.

On *Carex diandra, Douglasii, filifolia, Geyeri, heliophila, multicaulis, obtusata, oligocarpa* (Wis.), *petasata, praegracilis, Rossii, stenophylla.*

DISTRIBUTION: Semi-arid regions, North Dakota, and Montana south to Colorado and Utah, locally in Iowa and Wisconsin; also in Asia.

EXSICCATI: Barth. N. Am. Ured. *273, 475, 1080, 1476*—668, 872; Barth. Fungi Columb. *2446, 4275, 4376, 4675, 4980*—4165, 4469, 4765; Brenckle, Fungi Dakot. *106*; Clements, Crypt. Form. Colorad. *593*; Ellis & Ev. N. Am. Fungi *2219*; Ellis & Ev. Fungi Columb. *1641*—1664; Griff. W. Am. Fungi *277a, 360, 360a;* Syd. Ured. *1712*—2435.

One of the most interesting features about this species is its distribution. The fact that it occurs in the central part of North America and also in central Asia and that in each locality the original telial host is *Carex stenophylla* is worthy of note. The probable connection between these aecia and telia was suspected independently in the widely separated locations, by Dr. W. Tranzschel in Turkestan and by Rev. J. M. Bates in Nebraska, and numerous cultures have been since made but only the hosts, *C. stenophylla* and *A. dracunculoides* have been employed successfully. All of the other species of *Carex* are included here

with some uncertainty on account of the lack of culture evidence. They are included on the grounds of morphological similarity. The collection of *C. oligocarpa* is from Wisconsin and is further east than any of the others or any of the aecial collections but appears to belong here. With the exception of a single collection of pycnia on *Artemisia* from Iowa this stage of the species is not known to extend east of the Dakotas and Nebraska.

13. PUCCINIA PHRYMAE (Halst.) Arth. Jour. Myc. **14**: 22. 1908

Aecidium Phrymae Halst. Jour. Myc. **2**: 52. 1886.

O & I. Pycnia and aecia on *Phryma leptostachya*. (For cultures see Jour. Myc. **14**: 22, 1908.)

II. Urediniospores obovoid or broadly ellipsoid, 13–18 × 18–23 μ; wall light cinnamon-brown, 1–1.5 μ thick, finely and rather inconspicuously echinulate, the pores 2, in the upper part.

III. Teliospores clavate oblong, 12–18 × 29–45 μ, roundish or obtuse above, usually slightly narrowed below, slightly constricted at the septum; wall chestnut-brown, 1–1.5 μ thick, much thicker above, 7–13 μ; pedicel nearly colorless, about length of spore.

On *Carex Sprengelii* (*longirostris*).

DISTRIBUTION: In the telial stage known only from Madison, Wis., and Valentine, Nebr., the aecia have been collected also in Iowa, South Dakota, and New York.

EXSICCATI: Barth. N. Am. Ured. *956*, *1067*—253; Barth. Fungi Columb. *3958*.

This is a restricted species as to hosts both for the aecial and telial stages. The urediniospores are very like those of *Puc. asterum* but differences in the teliospores and the interval between the aecial host families seem sufficient to maintain this as a good species.

14. **Puccinia asterum** (Schw.) comb. nov.

Aecidium asterum Schw. Schr. Nat. Ges. Leipzig **1**: 67. 1822.

Aecidium Solidaginis Schw. Schrift. Nat. Ges. Leipzig **1**: 68. 1822.

Caeoma asteratum Link, in Willd. Sp. Pl. **6**[2]: 51. 1825.

Caeoma (*Aecidium*) *erigeronatum* Schw. Trans. Am. Phil. Soc. II. **4**: 292. 1832.

Aecidium Bellidiastri Unger, Exanth. Pfl. 109. 1833.

Aecidium Asteris Thüm. Myc. Univ. *935*. 1878.
Aecidium Lynosyridis Lagerh. Mitth. Bad. Bot. Ver. **46**. 1888.[7]
Puccinia extensicola Plowr. Monog. Ured. 181. 1889.
Puccinia firma Diet. Hedwigia **31**: 216. 1892.
Puccinia vulpinoidis Diet. & Holw.; Diet. Bot. Gaz. **19**: 304. 1894.
Puccinia tecta Ellis & Barth. Erythea **4**: 79. 1896.
Puccinia fusiformis Diet. Hedwigia **36**: 29. 1897.
Aecidium microsporum Diet. Hedwigia **36**: 34. 1897.
Dicaeoma extensicolum Kuntze, Rev. Gen. 3^3: 468. 1898.
Dicaeoma firmum Kuntze, Rev. Gen. 3^3: 468. 1898.
Dicaeoma vulpinoidis Kuntze, Rev. Gen. 3^3: 471. 1898.
Aecidium Grindeliae Sydow, Hedwigia Beibl. **40**: 1. 1901.
Puccinia Caricis-Erigerontis Arth. Jour. Myc. **8**: 53. 1902.
Puccinia Caricis-Asteris Arth. Jour. Myc. **8**: 54. 1902.
Puccinia Caricis-Solidaginis Arth. Bot. Gaz. **35**: 21. 1903.
Puccinia Dulichii Sydow. Monog. Ured. **1**: 684. 1903.
Puccinia Linosyridi-Caricis Ed. Fisher, Beitr. Krypt. Schweiz 2^2: 275. 1904.
Dicaeoma Caricis-Asteris Arth. Proc. Ind. Acad. Sci. **1903**: 147. 1904.
Dicaeoma Caricis-Erigerontis Arth. Proc. Ind. Acad. Sci. **1903**: 147. 1904.
Dicaeoma Caricis-Solidaginis Arth. Proc. Ind. Acad. Sci. **1903**: 147. 1904.
Dicaeoma Dulichii Arth. Proc. Ind. Acad. Sci. **1903**: 147. 1904.

O & I. Pycnia and aecia on *Aster, Doellingeria, Erigeron, Eucephalus, Euthamia, Grindelia, Leptilon, Oreochrysum* and *Solidago* spp. (For cultures see Jour. Myc. **8**: 53–55, 1902; Bot. Gaz. **35**: 15, 16, & 21, 1903: Jour. Myc. **11**: 58, 1904; Mycologia **2**: 224, 1909.)

II. Urediniospores globoid or broadly ellipsoid, 12–19 × 16–23 μ; wall light cinnamon-brown, 1–1.5 μ thick, finely echinulate, the pores 2, in the upper part.

III. Teliospores clavate or clavate-oblong, 12–20 × 35–50 μ, slightly or not constricted at the septum, usually rounded above; wall chestnut-brown, 1–1.5 μ thick, much thicker above, 5–10 μ; pedicel tinted next to the spore, about one half length of the spore.

[7] Reference not verified.

On *Carex alata, albolutescens, athrostachya, brevior, bromoides, canescens, cephaloidea, cephalophora, Crawfordii, cristatella, Deweyana, diandra, disperma, festivella* (formerly det. as *festiva*), *festucacea, foenea, gravida, Hookeriana, Houghtonii, interior, Jamesii, laeviculmis, Leavenworthii, Leersia, Muhlenbergii, Muskingumensis, oligocarpa, Pennsylvanica, planostachys, prairea, retrorsa, rosea, Rossii, scoparia, sparganioides, sterilis, stipata, suberecta, subfusca, Swanii, tenera, triangularis, tribuloides, trisperma, umbellata, varia, viridula, vulpinoidea* (also on *Dulichium arundinaceum*).

DISTRIBUTION: Common from Nova Scotia and Virginia west to the Pacific Coast, less common southward to Alabama and Texas, and in Alaska; also in South America and Europe.

EXSICCATI: Barth. N. Am. Ured. *25, 267, 535, 624, 651, 732, 733, 775, 827, 1031, 1032, 1140, 1180, 1226*—26, 226, 227, 228, 334, 421, 534, 623, 625, 626, 731, 824, 825, 826, 828, 829, 931, 976, 1029, 1030, 1135, 1136, 1138, 1139, 1337, 1442, 4565; Barth. Fungi Columb. *2366, 2574, 3743, 3862, 4274, 4455, 4564, 4755, 4766*—2302, 2448, 2656, 3250, 3251, 3352, 3454, 3455, 3547, 3548, 3744, 3839, 3932, 4053, 4054, 4142, 4257, 4258; Brenckle, Fungi Dakot. *241, 364, 364a*—107, 341, 341*a*; Carleton, Ured. Am. 45; Clements, Crypt. Form. Colorad. 692; Ellis & Ev. Fungi Columb. *1667, 1847, 4143*—64, 1391, 1502, 1705, 1707, 1708, 1955; Ellis, N. Am. Fungi 1019; Ellis & Ev. N. Am. Fungi 2402b; Garrett, Fungi Utah. *66*—65, 131, 155; Griff, N. Am. Fungi *277*—370; Kellerm. Ohio Fungi *89, 174*—150, 151; Sydow, Ured. *2132, 2386, 2411, 2412*—2515; Rab.-Wint.-Paz. Fungi eur. *3833*.

In its present form this is a comprehensive species including several forms which heretofore have passed as good species. Using the aecial hosts chiefly as a guide three distinct forms were recognized during the early stages of culture work in this country. These three forms were named *Puc. Caricis-Asteris, Puc. Caricis-Solidaginis,* and *Puc. Caricis-Erigerontis,* the names indicating the aecial connections. In view of the close relationship of the aecial hosts, the similarity of structure of the uredinial and telial stages, and certain cross cultures it now seems best to consider these forms as races of a single species. An examination of the long list of synonyms reveals several other items of interest. *Puc-*

cinia vulpinoidis will be noted as occurring on the list. This is a form in which the telia are long covered by the epidermis and it was not suspected for many years that it might belong in this group. Numerous cultures were attempted on a variety of plants known to bear aecia but without success. A careful morphological study, fortunate field observations, together with a consideration of the range of hosts finally led to the belief that it belonged here. Cultures as well as hosts indicate that it is the *Solidago* race, all attempts to cultivate it on *Aster* having failed (See Mycologia **7**:79–81). The long covered condition of the telial sorus seems to be associated with structural features of the host. Cultures which have shown that *Puc. Dulichii* is but a race of this large species are interesting because it is the only case where a *Carex* rust has been shown to occur on a telial host not belonging to the genus *Carex*. The report of its culture will be found in the reference to Mycologia above cited.

15. PUCCINIA PECKII (De Toni) Kellerm. Jour. Myc. **8**:20. 1902

Aecidium Oenotherae Mont. Hist. Chile **8**:37. 1852. Not *Puccinia Oenotherae* Vize. 1877.

Aecidium Oenotherae Peck, Ann. Rep. N. Y. State Mus. **23**:60. 1873.

Aecidium Peckii De Toni, in Sacc. Syll. Fung. **7**:790. 1888.

Puccinia ludibunda Ellis & Ev. Proc. Phil. Acad. **1893**:153. 1893.

Aecidium Gaurae Ellis & Ev. Erythea **1**:205. 1893.

Dicaeoma ludibundum Kuntze, Rev. Gen. 3^3: 469. 1898.

Dicaeoma Pecki Arth. Proc. Ind. Acad. Sci. **1903**:149. 1904.

O & I. Pycnia and aecia on *Gaura, Onagra, Meriolix,* and *Pacylophus* spp. (For cultures see Jour. Myc. **8**:20. 1902; Bot. Gaz. **35**:13. 1903. Jour. Myc. **11**:58. 1905. **12**:15. 1906.)

II. Urediniospores broadly ellipsoid or obovate, 15–20 × 21–26 μ; wall golden-brown, 1–1.5 μ, finely echinulate, the pores 2, in the upper part.

III. Teliospores clavate-oblong, 13–19 × 32–55 μ, the apex rounded or truncate, usually narrowed at the base, slightly constricted at the septum; wall chestnut-brown, paler below, about 1.5 μ, thicker at apex 7–11 μ; pedicel one half to once length of spore, nearly colorless.

On *Carex Asa-Grayii, chordorrhiza, Hookeriana, lanuginosa, Muhlenbergii, occidentalis, retrorsa, rostrata, siccata, sparganioides, trichocarpa, Willdenowii.*

DISTRIBUTION: Widely distributed from Maine and Virginia west to the Pacific Coast, also south to Alabama and New Mexico; especially abundant from Ohio to Colorado and the Dakotas.

EXSICCATI: Barth. Fungi Columb. *2569, 2570, 3850, 3956*—3460, 3563, 3669, 3955, 4157; Barth. N. Am. Ured. *47, 759, 1058*—53, *252*, 560, 652, 955, 1361, 1563; Brenckle, Fungi Dakot. *65*—65a, 112; Carleton. Ured. Am. *5*; Ellis & Ev. Fungi Columb. *1651, 1954*—1604, 1907; Ellis & Ev. N. Am. Fungi *3243*; Ellis N. Am. Fungi 1016; Kellerm. Ohio Fungi *28, 194*—17; Sydow, Ured. *1176, 1576*—2325.

A species of rather common occurrence and of wide distribution. Numerous cultures have clearly established the life history. The urediniospores have the same pore arrangement as those of *Puc. asterum* but the spores are larger. The telia are characterized by being unusually broad for their length, they are oval or even roundish, whereas most sedge rusts have oblong or linear telial sori. On *Carex trichocarpa* the sori of this species are frequently intermingled with those of *Puc. Sambuci.* The small roundish sori of *Puc. Peckii* are usually easily distinguished from the robust elongated sori of *Puc. Sambuci,* even without microscopic characters which would make separation certain.

16. PUCCINIA PATRUELIS Arth. Mycologia **1**: 245. 1909.

?*Caeoma* (*Aecidium*) *hieraciatum* Schw. Trans. Am. Phil. Soc. II. **4**: 292. 1832.

?*Aecidium* (*Caeoma*) *hieraciatum* Schw. Trans. Am. Phil. Soc. II. **4**: 309. 1832.

Aecidium Compositarum Lactucae Burrill; DeToni, in Sacc. Syll. Fung. **7**: 799. 1888.

?*Aecidium crepidicolum* Ellis & Gall. Jour. Myc. **6**: 31. 1890.

Puccinia Opizii (Bubak, misapplied by) Arth. Jour. Myc. **13**: 194. 1907.

O & I. Pycnia and aecia on *Adopogon* (*Cynthia, Krigia*) *Agoseris, Crepis, Lactuca, Hieracium,* and *Prenanthes* (*Nabalus*) spp. (For cultures see Jour. Myc. **13**: 194, 1907, Mycologia **1**: 245, 1909.)

II. Urediniospores ellipsoid or obovoid 15–20 × 20–26 μ; wall golden-brown, about 1.5 μ thick, moderately echinulate, the pores 2, in the upper part of the spore.

III. Teliospores narrowly clavate-oblong, 15–21 × 32–59 μ, rounded or truncate above, slightly or not constricted at the septum; wall chestnut-brown, somewhat paler below, 1–1.5 μ thick, much thicker at apex 5–13 μ; pedicel tinted next to the spore, about three-fourths length of the spore.

On *Carex aenia, brunnescens, Hoodii, illota, praegracilis, praticola, Reynoldsii, Sartwellii, siccata, Sprengelii.*

DISTRIBUTION: Michigan and Illinois westward to Utah, Oregon, and British Columbia.

EXSICCATI: Barth. N. Am. Ured. *758, 1065, 1066, 1165, 1264—702*; Barth. Fungi Columb. *3070, 3765, 4366*—3101, 3953, 3954, 4860; Brenckle, Fungi Dakot. *111, 242*—111a, 111b; Clements, Crypt. Form. Colorad. *314*; Ellis & Ev. Fungi Columb. *1902*—1601; Ellis & Ev. N. Am. Fungi. 2993, 3054; Griff, W. Am. Fungi *277c, 339a*—372a; Sydow, Ured. *2323.*

It is here assumed that all the American forms having aecia on members of the Cichoriaceae are referable to a single species. In 1906 cultures were made from an undetermined *Carex* on various species of *Lactuca.* At that time it was believed that the species was the same as one in Europe known to have aecia on *Lactuca* and the name proposed by Bubak, *Puc. Opizii,* was used. Two years later successful cultures were made with Colorado material on *Agoseris* and without suspecting its possible relationship to the so-called *Puc. Opizii* the name *Puc. patruelis* was proposed. When a more comprehensive study was made it became apparent that the American and European species are not identical but that all American forms with aecia on the closely related genera of the Cichoriaceae are without doubt the same species. *Puc. patruelis* then becomes the name, the Schweinitzian names above listed being doubtfully included.

17. PUCCINIA SAMBUCI (Schw.) Arth. Bot. Gaz. **35**: 15. 1903

Aecidium Sambuci Schw. Schr. Nat. Ges. Leipzig **1**: 67. 1822.
Caeoma (Aecidium) sambuciatum Schw. Trans. Am. Phil. Soc. II. **4**: 294. 1832.

Puccinia Bolleyana Sacc. Syll. Fung. 9:303. 1891.

Puccinia Atkinsoniana Diet.; Atkinson, Bull. Cornell Univ. 3:19. 1897.

Dicaeoma Bolleyanum Kuntze, Rev. Gen. 3^3:468. 1898.

Puccinia Thompsoni Hume, Bot. Gaz. 29:352. 1900.

O & I. Pycnia and aecia on *Sambucus* spp. (For cultures see Bot. Gaz. 35:14, 1903; Jour. Myc. 12:14, 1906, 13:195, 1907; Mycologia 1:233, 1909.)

II. Urediniospores lenticular or ellipsoid, 17–21 × 23–32 μ; wall light chestnut-brown, about 1.5 μ thick, rather finely echinulate, the pores 2, in the upper part.

III. Teliospores clavate-oblong or clavate, 15–25 × 42–65 μ, rounded above, usually narrowed below, somewhat constricted at the septum; wall chestnut-brown, 1.5–2 μ thick, much thicker at apex 7–13 μ; pedicel nearly colorless, about length of spore.

On *Carex Asa-Grayii, bullata, comosa, crinita, crus-corvi, Frankii, intumescens, lupuliformis, lupulina, lurida, trichocarpa.*

DISTRIBUTION: Eastern United States and Southern Canada from Nova Scotia and Wisconsin southward to Florida and Texas.

EXSICCATI: Barth. N. Am. Ured. *1569*; Barth. Fungi Columb. *3860, 4865*—3351; Kellerm. Ohio Fungi *57, 88, 148*—3.

A well-defined species both from the point of view of structural characters and aecial connections. It is characterized in the telial stage by the large well-developed sori and by the broad robust spores which are so well rounded above. The usual lenticular shape of the urediniospores is also especially characteristic of this species. No similar species has ever been reported from Europe.

18. PUCCINIA CARICIS-STRICTAE Dietel, Hedwigia 28:23. 1889

Uromyces Caricis Peck, Ann. Rep. N. Y. State Mus. 24:90. 1872. Not *Puccinia Caricis* Reb. 1804, or Schroet, 1887.

O & I. Pycnia and aecia unknown.

II. Urediniospores of the typical sort, ellipsoid or obovate, 13–20 × 20–25 μ; wall light cinnamon-brown, about 1.5 μ thick, finely and moderately echinulate, the pores 2, opposite, slightly below the equator; urediniospores of the modified sort (amphispores) globoid, obovate, or ellipsoid, 17–24 × 21–31 μ; wall dark cinna-

mon-brown, 1.5–2.5 μ thick, finely verrucose, the pores 2 slightly below the equator; pedicel colorless, semi-persistent, once or twice length of spore.

III. Teliospores clavate-oblong, 16–21 × 32–56 μ, usually rounded above, narrowed or rounded below, slightly constricted; wall light chestnut-brown 1–1.5 μ thick, much thicker above, 5–10 μ; pedicel nearly colorless, length of spore or less.

On *Carex stricta.*

DISTRIBUTION: Northeastern states from Massachusetts to New York and Delaware.

EXSICCATI: Barth. N. Am. Ured. *1033*; Thüm. Myc. Univ. *746.*

An interesting species on account of the presence of amphispores. The amphispores agree with the urediniospores in the arrangement of the pores but differ in being darker colored, in having verrucose instead of echinulate markings, and semi-persistent pedicels. Several collections without amphispores might be included based on the characters of the uredinial and telial stages but not without some uncertainty. A specimen from Connecticut and another from New York, both on *C. stricta,* with only urediniospores and teliospores, doubtless belong here but a specimen from Mississippi on *C. lacustris* has not been included. In spite of an essential agreement in urediniospore characters the geographical distribution, host relations, and lack of amphispores makes the situation too uncertain to list this host. The amphisporic collections are all on *Carex stricta* and are from the following localities: Seaford, Del., *Jackson;* Saratoga County and Albany, N. Y., *Peck;* Wellesley, Mass., *Seymour;* Southold, N. Y., *Latham.* Peck's original name *Uromyces Caricis* was based upon his error of taking amphispores to be one-celled teliospores.

19. PUCCINIA KARELICA Tranz. Acad. Sci. St. Petersburg Bot. **2**: 16. 1904

?*Aecidium Trientalis* Tranz.; Gobi & Tranz. in Scripta Bot. Hort. Imp. Petrop. **3**: 116. 1891.

O & I. Pycnia and aecia on *Trientalis* sp. (Cultures in Europe but not yet made with North American material although supported by field evidence.)

II. Urediniospores globoid or broadly ellipsoid, 16–19 × 20–24 μ; wall cinnamon-brown, 2–2.5 μ thick, finely and moderately echinulate, the pores 3–5, scattered.

III. Teliospores clavate-oblong, 13–21 × 26–48 μ, usually rounded above, rounded or narrowed below, slightly constricted at the septum; wall chestnut-brown, 1–1.5 μ thick, much thicker above, 7–12 μ; pedicel tinted, about one-half length of spore.

On *Carex canescens, paupercula.*

DISTRIBUTION: Nova Scotia to New York and Wisconsin.

The name *Puccinia karelica* Tranz. is applied with some doubt to the *Carex* rust here described. Tranzschel has cultured a form on *Carex limosa* to *Aecidium Trientalis* to which he has given the name *Puc. karelica.* Fraser in Nova Scotia has found good field evidence to the effect that a rust on *Carex paupercula* is connected with an aecial form on *Trientalis americana.* On the strength of the probability that the European and American forms belonging to aecia on *Trientalis* are the same the specific name *karelica* has been taken up. That which makes it seem uncertain is the fact that we find in the *Carex paupercula* rust 3 to 5 scattered pores while Tranzschel states that his form which produces *Aecidium Trientalis* is indistinguishable from *Puccinia Limosae* which has 3 to 4 equatorial pores.

INDEX OF ACCEPTED NAMES OF PUCCINIA ON CAREX

Numerical List	*Alphabetical List*
1. Kellermanii	asterum, 14
2. atro-fusca	atro-fusca, 2
3. macrospora	Caricis-strictae, 18
4. spatiosa	eminens, 9
5. minuta	Grossulariae, 8
6. urticata	karelica, 19
7. lysimachiata	Kellermanii, 1
8. Grossulariae	lysimachiata, 7
9. eminens	macrospora, 3
10. microsora	microsora, 10
11. minutissima	minuta, 5
12. universalis	minutissima, 11
13. Phrymae	patruelis, 16
14. asterum	Peckii, 15
15. Peckii	Phrymae, 13
16. patruelis	Sambuci, 17
17. Sambuci	spatiosa, 4
18. Caricis-strictae	universalis, 12
19. karelica	urticata, 6

INDEX TO THE RUST NAMES LISTED AS SYNONYMS

INDEX TO RUSTS OCCURRING ON THE VARIOUS SPECIES OF CAREX[8]

[8] Only the specific names are used since the hosts all belong to *Carex* and the rusts to *Puccinia*. *Carex* names italicized are regarded as synonyms.

Grossulariae, 8
triangularis Boeckl.
asterum, 14
tribuloides Wahl.
asterum, 14

umbellata Schk.
asterum, 14

varia Muhl.
asterum, 14
variabilis Bailey = aquatilis Wahl.
verrucosa Muhl.
minuta, 5
virescens Muhl.
Grossulariae, 8
viridula Michx.

Willdenowii Schk.

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Grossulariae, 8
Tuckermani Dewey
microsora, 10
typhina Michx.
Grossulariae, 8

usta Bailey = praegracilis W. Boott
utriculata Boott = rostrata Stokes

asterum, 14
urticata, 6
vitilis Fries = brunnescens (Pers) Poir
vulgaris Fries = Goodenowii J. Gay
vulpinoidea Michx.
asterum, 14

Peckii, 15